NAG C Library Function Document

nag_rngs_logarithmic (g05mdc)

1 Purpose

nag_rngs_logarithmic (g05mdc) generates a vector of pseudo-random integers from the discrete logarithmic distribution with parameter a.

2 Specification

```
void nag_rngs_logarithmic (Integer mode, double a, Integer n, Integer x[],
     Integer igen, Integer iseed[], double r[], NagError *fail)
```

3 Description

nag_rngs_logarithmic (g05mdc) generates n integers x_i from a discrete logarithmic distribution, where the probability of $x_i = I$ is

$$P(x_i = I) = -\frac{(a^I)}{(I \times \log(1-a))} \quad I = 1, 2, \ldots,$$

where $0 < a < 1$.

The variates can be generated with or without using a search table and index. If a search table is used then it is stored with the index in a reference vector and subsequent calls to nag_rngs_logarithmic (g05mdc) with the same parameter value can then use this reference vector to generate further variates.

One of the initialisation functions nag_rngs_init_repeatable (g05kbc) (for a repeatable sequence if computed sequentially) or nag_rngs_init_nonrepeatable (g05kcc) (for a non-repeatable sequence) must be called prior to the first call to nag_rngs_logarithmic (g05mdc).

4 References

Knuth D E (1981) *The Art of Computer Programming (Volume 2)* (2nd Edition) Addison–Wesley

5 Parameters

1: **mode** – Integer *Input*

On entry: a code for selecting the operation to be performed by the function:

mode $= 0$

Set up reference vector only.

mode $= 1$

Generate variates using reference vector set up in a prior call to nag_rngs_logarithmic (g05mdc).

mode $= 2$

Set up reference vector and generate variates.

mode $= 3$

Generate variates without using the reference vector.

Constraint: $0 \leq$ **mode** ≤ 3.

2: **a** – double *Input*

On entry: the parameter a of the logarithmic distribution.

Constraint: $0.0 < \mathbf{a} < 1.0$.

3: **n** – Integer *Input*

On entry: the number, n, of pseudo-random numbers to be generated.

Constraint: $\mathbf{n} \geq 1$.

4: **x**[**n**] – Integer *Output*

On exit: the n pseudo-random numbers from the specified logarithmic distribution.

5: **igen** – Integer *Input*

On entry: must contain the identification number for the generator to be used to return a pseudo-random number and should remain unchanged following initialisation by a prior call to one of the functions nag_rngs_init_repeatable (g05kbc) or nag_rngs_init_nonrepeatable (g05kcc).

6: **iseed**[4] – Integer *Input/Output*

On entry: contains values which define the current state of the selected generator.

On exit: contains updated values defining the new state of the selected generator.

7: **r**[dim] – double *Input/Output*

Note: the dimension, dim, of the array **r** must be at least $10 + \frac{40}{1-\mathbf{a}}$ when **mode** < 3 and at least 1 otherwise.

On exit: the reference vector.

8: **fail** – NagError * *Input/Output*

The NAG error parameter (see the Essential Introduction).

6 Error Indicators and Warnings

NE_INT

On entry, **mode** = ⟨*value*⟩.
Constraint: $0 \leq$ **mode** ≤ 3.

On entry, **n** = ⟨*value*⟩.
Constraint: $\mathbf{n} \geq 1$.

NE_DIM_INFEASIBLE

a is such that the reference vector length would exceed integer range. We recommend setting **mode** = 3. **a** = ⟨*value*⟩.

NE_PREV_CALL

a is not the same as when **r** was set up in a previous call. Previous value of **a** = ⟨*value*⟩, **a** = ⟨*value*⟩.

NE_REAL

On entry, $\mathbf{a} \leq 0.0$ or $\mathbf{a} \geq 1.0$: **a** = ⟨*value*⟩.

NE_BAD_PARAM

On entry, parameter ⟨*value*⟩ had an illegal value.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please consult NAG for assistance.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

The example program prints five pseudo-random integers from a logarithmic distribution with parameter $a = 0.999$, generated by a single call to nag_rngs_logarithmic (g05mdc), after initialisation by nag_rngs_init_repeatable (g05kbc).

9.1 Program Text

```
/* nag_rngs_logarithmic(g05mdc) Example Program.
 *
 * Copyright 2001 Numerical Algorithms Group.
 *
 * Mark 7, 2001.
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg05.h>

int main(void)
{
  /* Scalars */
  double   a;
  Integer  i, igen, n, nr;
  Integer  exit_status=0;
  NagError fail;

  /* Arrays */
  double   *r=0;
  Integer  *x=0;
  Integer  iseed[4];

  INIT_FAIL(fail);
  Vprintf("g05mdc Example Program Results\n\n");

  nr = 1;
  n = 10;
  /* Allocate memory */
  if ( !(r = NAG_ALLOC(nr, double)) ||
       !(x = NAG_ALLOC(n, Integer)) )
    {
      Vprintf("Allocation failure\n");
      exit_status = -1;
      goto END;
    }

  /* Set the distribution parameter A */
  a = 0.9999;
  /* Initialise the seed to a repeatable sequence */
  iseed[0] = 1762543;
  iseed[1] = 9324783;
  iseed[2] = 42344;
```

```
  iseed[3] = 742355;
  /* igen identifies the stream. */
  igen = 1;
  g05kbc(&igen, iseed);

  /* Generate integers and store in X */
  /* Use MODE=3 because A > 0.95 */
  g05mdc(3, a, n, x, igen, iseed, r, &fail);
  if (fail.code != NE_NOERROR)
    {
      Vprintf("Error from g05mdc.\n%s\n", fail.message);
      exit_status = 1;
      goto END;
    }
  for (i = 0; i < n; ++i)
    {
      Vprintf("%12ld\n", x[i]);
    }
 END:
  if (r) NAG_FREE(r);
  if (x) NAG_FREE(x);
  return exit_status;
}
```

9.2 Program Data

None.

9.3 Program Results

```
g05mdc Example Program Results

         262
          21
        8546
         737
           1
           1
          16
         197
          53
           3
```